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Nernst heat theorem for the thermal Casimir interaction between two graphene sheets

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Abstract

We find analytic asymptotic expressions at low temperature for the Casimir free energy, entropy, and pressure of two parallel graphene sheets in the framework of the Lifshitz theory. The reflection coefficients of electromagnetic waves on graphene are described on the basis of first principles of quantum electrodynamics at nonzero temperature using the polarization tensor in (2+1)-dimensional space-time. The leading contributions to the Casimir entropy and to the thermal corrections to the Casimir energy and pressure are given by the thermal correction to the polarization tensor at nonzero Matsubara frequencies. It is shown that the Casimir entropy for two graphene sheets goes to zero when the temperature vanishes, i.e., the third law of thermodynamics (the Nernst heat theorem) is satisfied. At low temperature, the magnitude of the thermal correction to the Casimir pressure between two graphene sheets is shown to vary inversely proportional to the separation. The Nernst heat theorem for graphene is discussed in the context of problems occurring in Casimir physics for both metallic and dielectric plates.

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